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RESEARCH ARTICLE

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Environmental transparency and investors' risk perception: Cross-country evidence on multinational corporations' sustainability practices and cost of equity

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Abstract

We explore whether a greater amount of environmental disclosure can reduce a firm's ex ante cost of equity. This could occur because the quantity of environmental information changes investors' risk perception of the company, thereby influencing its ex ante cost of equity. Our study is a cross-country analysis of 1481 multinational corporations (MNCs) across 43 countries and territories from 2013 to 2019. Firstly, we measure investors' risk perception as a firm's ex ante cost of equity by employing five different valuation models, all based on equity analysts' forecasted data. We then investigate whether large quantities of environmental information disclosed by an MNC affect its ex ante cost of equity. We find evidence that investors price the amount of environmental disclosure. More environmental disclosure decreases a firm's ex ante cost of equity because it lessens investors' information asymmetry. However, this relationship is non-linear. Once the amount of environmental disclosure data exceeds a certain threshold level, a firm's ex ante cost of equity will rise again. Our empirical results also suggest that non-financial factors at the country level play a role in shaping how investors perceive a firm's riskiness. Locating the firm in a country with better environmental performance and a higher score of the human development index can reduce investors' risk perception and result in a lower ex ante cost of equity. A policy implication of our findings is that a global standardised and effective corporate sustainability reporting is needed to provide investors a more holistic view for evaluating the riskiness of their investments.

KEYWORDS

cost of equity, country environmental performance, environmental disclosure, environmental policy, human development index, sustainability reporting

JEL CLASSIFICATION

G32; G34; L2; M41; M48

1 | INTRODUCTION

According to a recent survey (BAML, 2020), around 43% of global fund managers think that climate change is the factor among the environmental, social and governance (ESG) factors most likely to outperform in the 12 months following the survey. Although firms around the world are not always required by their local regulators to disclose their human rights records or greenhouse gas (GHG) emissions (Stanny, 2013), large institutional investors (e.g. Japanese Government Pension Fund and Norway's Sovereign Wealth Fund) are urged by global protestors (e.g. led by the environmental activist Greta Thunberg) to report their influence on the earth. International and supranational authorities also promote the inclusion of environmental factors in the capital allocation by investors (e.g., ECB, 2020; ESAs, 2021; IMF, 2019; OECD, 2020). At the regional level, the European authorities (ESMA, EBA and ECB) introduced measures to improve the relevant environmental disclosure (ECB, 2020; ESAs, 2021). In 2021, the German constitutional court declared the German government's climate protection goal as insufficient, thereby ruling in favour of young environmental activists who had brought the case (Guardian, 2021). Based on the literature (Cui et al., 2019; Hong & Kacperczyk, 2009), we can surmise that shared beliefs and values of environmental protection are growing strongly across countries. Investors start urging firms to disclose environmental impact information including GHG emissions to the relevant stakeholders. As a result, environmental campaigns and policy interventions may reduce investors' demand for certain types of companies such as oil- or coal-producing firms, and social movements highlighting their poor sustainability level could ultimately drive up these firms' cost of equity (OECD, 2020).

Firms who aim to maximise value will try to lower their cost of equity as much as possible. Prior literature on a firm's relation between corporate social responsibility (CSR)/or environmental issues and its ex ante cost of equity is mostly constrained to single-country studies (Dhaliwal et al., 2011; El Ghoul et al., 2011; Kim et al., 2015; Plumlee et al., 2015; Sharfman & Fernando, 2008). Very few studies have examined the topic from an international perspective. The exceptions are El Ghoul et al. (2018) who find a negative relationship between environmental performance and ex ante cost of equity and Breuer et al. (2018) who document that a firm with better performance in social and governance issues can reduce its cost of equity where investor protection is strong. We contribute to this strand of the cost of equity literature by researching whether investors price the quantity of environmental information disclosed by a firm. Our other contribution is to address the lack of global analyses in the relevant literature. We carry out a cross-country analysis of 1481 multinational corporations (MNCs) across 43 countries and territories during the period 2013–2019. The ex ante equity financing cost, which we estimate for each of our sample firms, is an appropriate forward-looking measurement that reflects how investors perceive a firm's riskiness (Chen et al., 2009; El Ghoul et al., 2011, 2018; Hail & Leuz, 2006). Using a firm's ex ante equity cost, we can examine whether the quantity of environmental information that a firm opts to disclose to the public can influence investors' risk perception. In the process of estimating the ex ante cost of equity, we employ five valuation approaches for each sample firm, collecting equity analysts' forecasted fundamental variables such as earnings per share. In this study, we use averages of those valuation models to gauge the firms' ex ante cost of equity in order to avoid distortions and measurement problems from any particular approach.

We also explore whether country factors play a role in determining how investors perceive a firm's riskiness after controlling for the level of environmental disclosure. In particular, non-financial factors at the country level have received less attention in the environmental literature. In the CSR literature, scholars (Breuer et al., 2018; Cai et al., 2016; Lau et al., 2010) document that the ex ante cost of equity is likely to vary across these MNCs due to the differences in the country institutional qualities, the firms' individual abilities to respond to macroeconomic and financial market conditions, the qualities of corporate governance at the firm level and other factors. In this study, we choose to focus on MNCs. Many companies throughout the world have become multinational not only in the scale of their global business operations but also in internationalising their capital structure by raising funds from more than one stock exchange (Stonehill & Dullum, 1982). We examine the latter type of MNCs, which have raised capital from domestic as well as from foreign financial sources. These firms are usually the largest firms in their home country in terms of market capitalisation. How these firms manage their environmental disclosure and cost of equity is likely to be the centre of public interest and thus a benchmark for purely domestic firms and non-cross-listed firms.

In this study, we firstly demonstrate that there is a potentially non-linear relationship between a firm's environmental disclosure and its ex ante cost of equity. A firm can minimise its ex ante cost of equity by choosing the optimal environmental disclosure level because of a reduction of investors' information asymmetry. Indeed, although most of the previous studies focus on the linear relationship between a firm's environmental disclosure in CSR/or environmental dimensions and its ex ante cost of equity, our empirical results suggest that there is a non-linear relationship between these two factors. We show that greater disclosure of environmental information initially reduces a firm's ex ante cost of equity. However, its ex ante cost of equity will increase once a certain threshold quantitative level of environmental disclosure is exceeded. We estimate the turning point for a firm's environmental disclosure score as 84.6 out of a maximum disclosure score of 100, while the mean (median) of the environmental disclosure for all our sample firms is 33.3549 (34.8837). For the vast majority of our sample firms, environmental disclosure benefits outweigh the costs. Our empirical evidence shows that a firm's environmental quantitative disclosure is value relevant to the investors via the mechanism of reducing market information asymmetry.

We also find that investors do not assess a firm's GHG intensity in isolation, but rather in association with the quantity of this firm's environmental information available to the public. Due to a decrease in the investor information asymmetry, a firm can eventually bring down the risk premium required by its shareholders and compensate for poor past performance in GHG intensity by disclosing more environmental information.

Finally, we enhance the understanding of how non-financial factors at the country level also play a role in determining how investors perceive a firm's riskiness. Our empirical findings suggest that multinational firms enjoy a lower ex ante cost of equity when their senior management is located in a country with a better country environmental performance or greater human development progress (human development index [HDI]). We obtain similar empirical results if we replace a country's human development progress (HDI) with the extent to which a country's citizens have freedom of expression in their beliefs. Although non-financial country factors have received little attention in the environmental literature, we contribute to the literature by providing empirical evidence for the importance of non-financial country factors. Needless to say, examining the role of a country's environmental performance in relation to firms' environmental disclosure policies is of interest to MNCs and policymakers.

Our paper is structured as follows. In Section 2, we discuss the theoretical background by reviewing the prior literature and develop three testable hypotheses. We describe the research design in Section 3 and discuss the empirical results in Section 4. Section 5 concludes.

2 | THEORETICAL BACKGROUND AND HYPOTHESES DEVELOPMENT

We explore whether and how the amount of environmental information disclosed by a firm can influence investors' perception of a firm's riskiness and its required risk premium. Firstly, we propose to use the ex ante equity cost as an appropriate measure of investors' forward-looking perception of a firm's riskiness. We then investigate how the amount of environmental data disclosed by this firm will influence investors' perception of its risk. We also aim to address the lack of global analyses in the relevant literature. Since this is a cross-country study composed of MNCs, we examine whether the variation of non-financial country-level factors can impact investors' perception of this firm's riskiness. In this section, we develop our hypotheses based on the key theoretical idea of investors' market information asymmetry. We start with the definitions of our two key concepts.

2.1 | A firm's quantity of environmental disclosure

To contribute to the strand of the cost of equity literature, we focus on whether investors price the quantity of environmental information disclosed by a firm. Currently, there are no particular regulatory guidelines or a global authority to supervise how companies release their environmental data to stakeholders (Álvarez Jaramillo et al., 2018; Friede, 2019; PRI, 2017) although supranational policymakers are making efforts towards standardisation (e.g. OECD, 2020). For each country, firms must rely on their local or regional (such as the European Union [EU]) mandatory and voluntary disclosure instruments in order to realise the environmental recommendations provided by the United Nations, the Sustainability Accounting Standards Board, Impact Reporting and Investment Standards and the Global Reporting Initiative (Landrum & Ohsowski, 2018; Yu et al., 2018). Due to the flexibility firms are given in the current situation, firms can in practice decide the quantity of environmental information they reveal to the public. This enables us to examine how the quantity of environmental information disclosed by a firm can change investors' risk perception and influence the required risk premium. Following the prior literature (Benlemlih et al., 2018; Siew et al., 2016; Tamimi & Sebastianelli, 2017), we use the Bloomberg environmental disclosure score, which measures the amount of environmental information a firm reveals to its stakeholders. All environmental information is counted. Note that this environmental disclosure score is independent of whether the environmental information is negative or positive. A firm with a higher Bloomberg environmental disclosure score simply means that this firm is more transparent in environmental issues.

2.1.1 | A firm's ex ante cost of equity

Following the prior finance literature (Chen et al., 2009; El Ghoul et al., 2011, 2018; Hail & Leuz, 2006), we adopt the ex ante cost of equity as a measure of investors' perception of a firm's riskiness. Scholars (Hail & Leuz, 2006; Pástor et al., 2008) suggest that the ex ante cost of equity is an appropriate metric representing a firm's expected risk premium because a firm's future earnings and its growth potential are considered in the process of estimating a firm's ex ante cost of equity. We provide more detailed information on how we use five valuation models to estimate the ex ante cost of equity for our sample firms in the research methodology section.

2.1.2 | The relationship between environmental disclosure and cost of equity

In this section, we develop our three hypotheses based on the concept of investors' information asymmetry. We study the relation between a firm's amount of environmental information disclosure and its ex ante equity cost via investors' perception of the company's risk. Based on the stakeholder theory (Dhaliwal et al., 2011; Freeman & McVea, 2001; Sanches Garcia et al., 2017), scholars suggest that sustainable companies are aligned with all stakeholders' interests. Therefore, a sustainable firm is motivated to achieve high levels of transparency in order to alleviate the information asymmetries between itself and all relevant stakeholders (Cheng et al., 2014; Dhaliwal et al., 2011; Merton, 1987; Verrecchia, 2001; Yu et al., 2018). This can also explain why a recently emerging shared belief—stakeholders persuading firms to report their influence on the planet—has pushed corporate environmental disclosure into the mainstream. When a firm reveals more environmental information, a reduction of information asymmetry can lower investors' risk perception of a firm, resulting in a drop of the required risk premium and thus a lower ex ante cost of equity.

Prior literature shows that equity analysts or investors price the amount of environmental or CSR information in their investment recommendations and decisions (Albarrak et al., 2018; Griffin et al., 2017; Rjiba et al., 2021; Sharfman & Fernando, 2008). For instance, Dhaliwal et al. (2011) suggest that US companies initiating information disclosure in the CSR dimension enjoy a lower cost of equity than non-initiating firms. Siew et al. (2016) also find that for companies listed on the New York Stock Exchange, greater quantities of disclosure in the ESG dimensions can significantly reduce information asymmetry. To address the relation between a firm's environmental disclosure and its ex ante cost of equity, we illustrate how a firm's amount of environmental disclosed information can change investors' risk perception through the mechanism of investors' information asymmetry. Based on market information theory, a firm that reveals greater quantities of environmental data to the public can reduce the information asymmetry between investors (i.e. shareholders as the principals) and a firm's management (acting as the agent). Consequently, a firm disclosing more environmental information is seen as less risky by investors, and investors may request a lower risk premium for investing, resulting in a reduction in the cost of equity. Another ripple effect is that this firm is likely to expand its investor base because of a decrease in investors' perceived risk. A rise in demand from its potential investors may result in a cheaper cost of equity for the firm (Breuer et al., 2018; Bui et al., 2019; El Ghoul et al., 2018; Kim et al., 2015; Merton, 1987). Conversely, firms recognised by investors to be involved in environmental or CSR misconduct are penalised by investors, thus requiring a higher risk premium to compensate for a possible future financial loss from environmental fines. The corresponding outcome for these firms will be a rise in their cost of equity (Bui et al., 2019; Dhaliwal et al., 2011; El Ghoul et al., 2018).

Yet, it remains an unresolved empirical question in the literature whether this relationship between the ex ante cost of equity and non-financial disclosure is linear or non-linear. Additionally, the prior literature concentrates mostly on single-country studies (Dhaliwal et al., 2011; El Ghoul et al., 2011; Kim et al., 2015; Plumlee et al., 2015; Sharfman & Fernando, 2008). For instance, some scholars (Albarrak et al., 2018; Matsumura et al., 2014) find a linear relation between a firm's cost of equity and its adjusted disclosure level in CSR and environmental issues. Furthermore, previous studies (Attig et al., 2013; Cheng et al., 2014) document that capital constraints can fall if a firm's transparency is enhanced. However, some scholars (Barnea & Rubin, 2010; Borghesi et al., 2014; Trumpp & Guenther, 2017) show that additional investment in CSR/environmental issues may not be able to enhance shareholders' value without a limit.

To contribute to the existing literature, we use an international dataset to explore whether a firm's greater amount of environmental disclosure can lower a firm's ex ante cost of equity without limit. We propose that a firm increases its environmental disclosure level towards a level where its ex ante cost of equity is minimised, but beyond that point the ex ante cost of equity will start rising. We illustrate the trade-offs a firm could encounter by using a simple one-period model. Refer to Equation 1. We assume that the firm chooses the optimal environmental disclosure level to minimise its cost of equity.

$$\text{Influence on a firm's ex}-\text{ante cost of equity} = \alpha - \theta X^{\gamma} + \omega X^{\tau} \quad (1)$$

X represents a firm's environmental disclosure level. By assuming $\theta,\gamma,\omega,\tau > 0$, we can measure the influence on a firm's ex ante cost of equity with the magnitudes of these four parameters. Consequently, $\theta,\gamma,\omega,\tau$ affect the shape of Equation 1. θX^{γ}denotes the benefit a firm receives from disclosing its environmental data, which can lower its ex ante cost of equity further. Oppositely, ωX^{τ} captures the firm's disclosure cost through investors' risk perception, which raises its ex ante cost of equity. We also predict that the magnitudes of $\theta,\gamma,\omega,\tau$ are likely to be influenced by the firm- and country-level factors such as different levels of corruption, political rights, the human development progress at country level or the percentage of institutional investors at a company level (Cai et al., 2016; Cooper et al., 2010; Marquis et al., 2016; Yu et al., 2020). By using this simple one-period model, we can demonstrate that there is a potentially non-linear relationship between a firm's environmental disclosure and its cost of equity. According to Equation 1, the influence from X, which represents a firm's environmental disclosure level, will be linear only if $\gamma = \tau = 1$.

The economic rationale for a non-linear relationship between environmental disclosure and ex ante cost of equity is as follows. Due to a reduction of the investors' information asymmetry, the required risk premium initially decreases via a reduction in perceived environmental risks. Consequently, a company is likely to expand its investor base due to an increased demand from its potential investors. Therefore, a reduced required risk premium from investors and an increase in its investor base lead to a lower ex ante cost of equity. Meanwhile, the more environmental data a firm discloses, the more scrutiny it will receive from the relevant stakeholders. This may result in environmental disclosure costs through investors' higher risk perception, which at some level of disclosure could overwhelm the benefits of transparency.

The discussion above leads to our Hypothesis 1. We hypothesise that firms can minimise their ex ante cost of equity by selecting the optimal disclosure level in environmental issues because of a reduction of shareholders' information asymmetry. If this is the case, the disclosed environmental information becomes value relevant to the shareholders (Albarrak et al., 2018; Dhaliwal et al., 2011; Matsumura, 2014).

> **Hypothesis 1.** Greater quantities of environmental disclosure can reduce a firm's ex ante cost of equity in the subsequent year because it reduces shareholders' information asymmetry. However, this is potentially not a linear relationship.

Furthermore, we explore how a firm's amount of environmental disclosure can change investors' risk perception through another channel, a decrease of information asymmetry via the joint effect of environmental disclosure with a higher GHG intensity[1] in the previous

year. We investigate whether large quantities of disclosed environmental data can lower investors' perception of a firm's riskiness linked with its prior year's GHG emissions. The rationale of Hypothesis 2 is also built upon the theoretical idea of investor information asymmetry. We predict this joint effect to lower a firm's ex ante cost of equity since potential market information asymmetry is lessened. We assume that firms which are recognised by investors to be involved in greater GHG emissions and environmental misconduct will be penalised by investors in the subsequent year. Investors perceive these firms as riskier investments, thus requiring a higher risk premium to compensate for a possible financial loss from future environmental fines. Consequently, these firms will experience an increase in their ex ante cost of equity (Bui et al., 2019; Dhaliwal et al., 2014; El Ghoul, 2018; Gerged et al., 2021). Some scholars (Bui et al., 2019; Dhaliwal et al., 2011; Kim et al., 2015) find supporting empirical evidence for this argument. Furthermore, Gerged et al. (2021) document that UK firms with greater GHG emission risk are more willing to disclose environmental information to the public. Following the prior literature, we argue that firms with greater GHG intensity which disclose greater amount of environmental information to the public in the subsequent year can reduce information asymmetry and lower their investors' risk perception and their ex ante cost of equity.

This leads to Hypothesis 2, which provides insight into whether large quantities of disclosed environmental data can change investors' perception of a firm's riskiness linked with its prior year's GHG emissions.

> **Hypothesis 2.** We predict that a firm with a higher GHG intensity will benefit from a reduced ex ante cost of equity if environmental disclosure is greater in the subsequent year because of a reduction of information asymmetry.

2.1.3 | Do non-financial country factors matter in shaping investors' perception of a firm's riskiness?

The literature (Breuer et al., 2018; Bui et al., 2019; Lau et al., 2010) observes that the cost of equity varies substantially across countries. Most environmental studies concentrate on the influence of economic factors on the cost of equity at the country level. By contrast, some studies suggest that non-financial country factors also play as important a role as economic factors (such as GDP per capita) in corporate social and environmental issues (Breuer et al., 2018; Cai et al., 2016; Cheung et al., 2020; Ioannou & Serafeim, 2012). For instance, Yu et al. (2020) document that a country's national well-being can effectively alleviate firms' greenwashing conduct in non-financial disclosures. Bui et al. (2019) document that companies locating in a country with better institutional qualities have an incentive to enhance their disclosure of carbon data to the public. To contribute to the environmental literature, we examine whether investors price non-financial country factors. In Hypotheses 3a and 3b, we focus on two non-financial factors: 'country environmental performance' and 'a country's human development progress', which may influence investors' risk perception. Our Hypotheses 3a and 3b are also grounded in the idea of investors' market information asymmetry.

Country environmental performance

Scholars have found evidence showing that a firm's environmental policies and its reputation in environmental issues can change acquirers', institutional investors' and individual investors' risk perception (Bloomberg Intelligence, 2018; Boone & Uysal, 2018; Fernando et al., 2017). In Hypothesis 3a, we explore whether a firm's domicile country's environmental performance can influence the ex ante cost of equity via changing investors' risk perception.

Following the relevant environmental/CSR literature (Boone & Uysal, 2018; Dhaliwal et al., 2011; Lev et al., 2010; Rodriguez et al., 2006), the rationale for this relationship is based on the idea of investors' information asymmetry. In recent years, information on country environmental performance ranking has become freely and easily accessible to investors and other stakeholders. Various organisations publish annual online country rankings of environmental issues, such as Germanwatch or the Yale Centre for Environmental Law and Policy. A country that provides better policies and schemes in the environmental and social dimensions can help firms enhance employee welfare and achieve better performance in environmental and social issues. Consequently, the potential reduction of pollution and legal and employees' medical costs implies greater production efficiency and could provide a positive cash flow impact in the future (Boone & Uysal, 2018; Bui et al., 2019; Dhaliwal et al., 2011). With a better environmental business environment, investors may perceive firms to be less likely to suffer from environmental scandals in the short term, which can result in a lower perceived riskiness. The discussion above leads to Hypothesis 3a.

> **Hypothesis 3a.** We predict that investors perceive a firm to be less risky, and therefore require a lower ex ante cost of equity, when it is located in a country with a better country environmental performance.

If this hypothesis holds, investors price country environmental performance in their investment process.

Human development progress at country level

Some researchers find that social, ethnic and national well-being or religious factors can shape the way individuals think, which affects their financial decisions (Cui et al., 2019; Friede, 2019; Guiso et al., 2008; Heinkel et al., 2001; Hong & Kacperczyk, 2009; Stulz & Williamson, 2003). For instance, Bailey et al. (2008) suggest that more affluent, experienced and sophisticated investors are more likely to look beyond their home market in their investments. In a similar vein, we examine how a country's human development progress may potentially influence investors' risk perception of companies domiciled in that country, which so far received little attention in the environmental literature. We develop Hypothesis 3b based on the idea of investors' information asymmetry. Following the prior literature (Cai

et al., 2016; Yu et al., 2020), we quantify a country's human development progress by adopting the HDI from the United Nations (UNDP, 2018), which measures a country's overall national well-being, not economic progress alone. Each country in this index is evaluated in the following three areas equally: (a) a decent standard of living, (b) a healthy life and life expectancy and (c) knowledge and education attainment.

The rationale for Hypothesis 3b is as follows. We suggest that investors in a country with a better human development progress have greater opportunities and better abilities to maximise the use of all available public information (Albarrak et al., 2018; Bansal & Kistruck, 2006; Cai et al., 2016; Kim & Youm, 2017; Lyon & Montgomery, 2013). For example, Rjiba et al. (2021) document that complicated textual annual reports inhibit investors' ability to understand these reports, resulting in greater information risk and a higher cost of equity financing. Kim and Youm (2017) study how US individual investors can potentially influence equity analysts' recommendations by engaging with firms' corporate Twitter accounts. We argue that investors living in a country with an insufficient human development progress face greater market information asymmetry than those who live in a country with a greater human development progress. Moreover, we also predict a broader investor base is likely to develop for firms located in a country with better human development progress. Citizens in a country with higher human development progress are more aware of firms' existence in their local stock exchanges, and more people can participate in investment activities (Bailey et al., 2008). As more citizens participate in this risk sharing, a broader investor base can change other investors' risk perception, making firms located in the country less risky ex ante (Breuer et al., 2018; Merton, 1987). All these factors (such as local investors who have better abilities and opportunities to maximise the use of all publicly available information) contribute to a lower ex ante cost of equity required by investors. Our discussion leads to Hypothesis 3b. In this hypothesis, we explore whether an MNC can reduce its ex ante cost of equity by being headquartered in a country with greater country human development progress.

> **Hypothesis 3b.** An MNC may reduce its cost of equity by being headquartered in a country with better country human development progress, a higher score on the human development index.

3 | RESEARCH DESIGN

3.1 | Model, sample construction and data

In this section, we discuss our company sample construction, data and theoretical model. Firstly, we estimate a firm's ex ante cost of equity, as proxied for investors' risk perception, by employing five different valuation models. All these valuation models are based on equity analysts' forecasted data. The prior literature shows that using a firm's ex ante equity cost is an appropriate measure of investors' forward-looking perception of the firm's riskiness (Chen et al., 2009; El Ghoul et al., 2011, 2018).

Then, we investigate whether the quantity of environmental information disclosed by an MNC affects its cost of equity. Our sample is comprised of multinational firms that are available in the following three databases: Refinitiv Eikon, Thomson Reuters I/B/E/S and Bloomberg. We collect and merge these three databases to establish our own cross-country dataset. We start with all constituent companies of the MSCI All Country World Index (ACWI) and only select the firms which have raised their funds from more than one stock exchange as our sample firms. We end up with an unbalanced panel cross-country dataset comprised of 1481 firms across 43 countries and territories that encompasses 10,367 firm-year observations during the sample period 2013–2019.

3.1.1 | Model

Investors' risk perception: Estimating the ex ante cost of equity

Following the recent finance literature, we adopt the ex ante cost of equity as an appropriate proxy for investors' risk perception on an MNC (Chen et al., 2009; El Ghoul et al., 2011, 2018; Hail & Leuz, 2006). Since the ex ante cost of equity is a forward-looking estimation method taking into account a firm's future earnings and its growth potential, it is a better predictor of a firm's expected risk than estimators based on the historical beta premium (Hail & Leuz, 2006; Pástor et al., 2008). In a similar vein, scholars (Chen et al., 2009; El Ghoul et al., 2018; Fama & French, 1997) suggest that ex post realised returns are inadequate measurements for a firm's cost of equity. Therefore, we calculate the ex ante cost of equity for each of our sample firms based on equity analysts' forecasts of earnings per share and other corporate data as well as share prices.

We estimate the ex ante cost of equity as the internal rate of return from employing the five different valuation approaches developed by Claus and Thomas (2001) (as our Model 1), Ohlson and Juettner-Nauroth (2005) (as our Model 2), Gebhardt et al. (2001) (as our Model 3) and Easton (2004) (as our Model 4). The fifth model uses the forward earnings/price ratio, a common estimator adopted by investment professionals (Pinto, 2020). To estimate the ex ante implied cost of equity for our sample firms, we collect equity analysts' forecasted information for each firm, including the values of forecasted earnings per share from Thomson Reuters I/B/E/S. We display these five valuation models in Table 1. We also summarise the detailed implementation processes for each model in Appendix A.

Following previous studies (Chen et al., 2009; El Ghoul et al., 2011, 2018), we take the average value of the ex ante cost of equity derived from all these five models as our main dependent variable, COE_A . In this study, we also present two additional versions of a firm's ex ante cost of equity: COE_B and COE_C. COE_B represents the average value of the first four models, which are developed by academics. COE_C represents the value of Model 5, which is often used by practitioners.

TABLE 1 To estimate the ex ante implied cost of equity using five models

Model (i)	Reference	Equation	No.
1	Claus and Thomas (2001)	$P_{0=}B_0+\frac{(FEPS_1-R_i*B_0)}{(1+R_i)^1}+\frac{(FEPS_2-R_i*B_1)}{(1+R_i)^2}+\frac{(FEPS_3-R_i*B_2)}{(1+R_i)^3}+\frac{(FEPS_4-R_i*B_3)}{(1+R_i)^4}+\frac{(FEPS_5-R_i*B_4)}{(1+R_{1i})^5}+\frac{(FEPS_5-K_{CT}*B_4)*(1+i_0)}{(R_i-i_0)*(1+R_i)^5}$	(2)
2	Ohlson and Juettner-Nauroth (2005)	$P_0=\frac{FEPS_1\left(\frac{1}{2}*\left(\frac{FEPS_2-FEPS_1}{FEPS_1}+\frac{FEPS_3-FEPS_2}{FEPS_2}\right)-i_0+R_i*K_1\right)}{R_i\ (R_i-i_0)}$	(3)
3	Gebhardt et al. (2001)	$P_0=B_0+\left[\frac{(FROE_1-R_i)}{(1+R_i)^1}B_0+\frac{(FROE_2-R_i)}{(1+R_i)^2}B_1+\frac{(FROE_3-R_i)}{(1+R_i)^3}B_2+\frac{(FROE_4-R_i)}{(1+R_i)^4}B_3+\frac{(FROE_5-R_i)}{(1+R_i)^5}B_4+\frac{(FROE_6-R_i)}{(1+R_i)^6}B_5+\frac{(FROE_7-R_i)}{(1+R_i)^7}B_6+\frac{(FROE_8-R_i)}{(1+R_i)^8}B_7+\frac{(FROE_9-R_i)}{(1+R_i)^9}B_8+\frac{(FROE_{10}-R_i)}{(1+R_i)^{10}}B_9+\frac{(FROE_{11}-R_i)}{(1+R_i)^{11}}B_{10}\right]+\frac{(FROE_{12}-R_i)}{(1+R_i)^{11}R_i}*B_{11}$	(4)
4	Easton (2004)	$P_0=\frac{FEPS_2-FEPS_1*(1-R_i*K_1)}{(R_i)^2}$	(5)
5	Forward earnings/price ratio (Pinto, 2020)	$R_i=\frac{FEPS_1}{P_0}$	(6)
All the key variables used in these five valuation models are defined below.			
R_i	*The ex ante cost of equity to be solved for*		
i_0:	*The expected perpetual earnings growth at year 0. We use a country's next year's realised inflation rate collected from the IMF World Economic Outlook Database and then weighted average of all our 43 sample countries in terms of their market capitalisation as the expected perpetual earnings growth rate at year zero in this equation*		
K_t:	*The expected dividend payout rate*		
$FROE_{t+j}$:	*Forecasted return on equity for year t+j*		
$FEPS_{t+j}$:	*Forecasted earnings for year t+j*		
B_t:	*Current book value per share*		
B_{t+j}:	*Forecasted book value per share for year t+j*		

By taking the average of these valuation models, we can avoid distortions and measurement problems from any particular model and ensure a robust gauge of a firm's ex ante cost of equity across the five estimation methods. In this study, the average ex ante cost of equity in our sample is 10.34%, and the median value is 9.16%.

Our main model

Our primary model investigates whether large quantities of environmental disclosure can reduce a firm's ex ante cost of equity ($COE_{i,t}$), that is, if a greater amount of environmental disclosure (*ENVDIS*) can change investors' risk perception of the company, thereby influencing its ex ante cost of equity. We also examine whether investors price the following two non-financial country factors into their investment decisions, 'country environmental performance' and 'a country's human development progress (HDI)', which may impact investors' risk perception. These represent our key variables together with the environmental disclosure (*ENVDIS*) that we detail below. To allow for a potential non-linearity to occur between a firm's environmental disclosure and ex ante cost of equity, we add a quadratic term for environmental disclosure to the major equation. The primary equation is displayed below.

$$\begin{aligned}
COE_{i,t} &= \alpha + \beta_1(ENVDISC_{t-1}) + \beta_2 * (ENVDISC_{t-1})^2 + \beta_3 \\
&\quad * (ENVDISC_{t-1} * GHG\ Intensity_{t-2}) + \beta_4 \\
&\quad * [GHG\ Intensity\ or\ (GHG\ Scope1/EBITDA)]_{t-1} + \beta_5 \\
&\quad * (country\ environmental\ performance_{t-1}) + \beta_6 \\
&\quad * (country's\ human\ development\ progress\ )_{t-1^+} \sum \gamma * Control_{ijt} \\
&\quad + \sum \tau_m * Industry_m + \sum \omega_k Year_k \\
&\quad + \varepsilon_{it} (country's\ human\ development\ progress\ )_{t-1^+} \sum \gamma \\
&\quad * Control_{ijt} + \sum \tau_m * Industry_m + \sum \omega_k Year_k + \varepsilon_{it} \\
&= \alpha + \beta_1(ENVDISC_{t-1}) + \beta_2 * (ENVDISC_{t-1})^2 + \beta_3 \\
&\quad * (ENVDISC_{t-1} * GHG\ Intensity_{t-2}) + \beta_4 \\
&\quad * [GHG\ Intensity\ or\ (GHG\ Scope1/EBITDA)]_{t-1} + \beta_5 \\
&\quad * (country\ environmental\ performance_{t-1}) + \beta_6 \\
&\quad * (country's\ human\ development\ progress\ )_{t-1} + \gamma_1 * Beta_t + \gamma_2 \\
&\quad * Sigma_t + \gamma_3 * Market\ capitalisation_{t-1} + \gamma_4 * Leverage_{t-1} + \gamma_5 \\
&\quad * *RD_{t-1} + \gamma_6 * ROA_{t-1} + \gamma_7 * (Current\ ratio)_{t-1} + \gamma_8 \\
&\quad * (Sales\ growth)_{t-1} + \gamma_9 * Disclosure\ growth_{t-1} + \gamma_{10} \\
&\quad * \log(Board\ size_{t-1}) + \gamma_{11} * Insider_{t-1} + \gamma_{12} * (ENVDISC_{t-1}) \\
&\quad * Insider_{t-1} + \gamma_{13} * Institional_{t-1} + \gamma_{14} * (ENVDISC_{t-1}) \\
&\quad * (country's\ human\ development\ progress\ or\ Voice)_{t-1} + \gamma_{15} \\
&\quad * \log(GDP)_{t-1} + \gamma_{16} * (Political\ Stability)_{t-1} + \gamma_{17} \\
&\quad * (Regulatory\ Quality)_{t-1} + \gamma_{18} * (Rule\ of\ Law)_{t-1} + \gamma_{19} \\
&\quad * (Control\ of\ Corruption)_{t-1} + \sum \tau_m \\
&\quad * Industry_m + \sum \omega_k Year_k + \varepsilon_{it}
\end{aligned} \tag{7}$$

where

Our dependent variable is $COE_{i,t}$, a firm's ex ante cost of equity.

Our key independent variables are (a) a firm's quantity of environmental disclosure (ENVDISC), (b) country environmental performance and (c) human development progress at country level (HDI).

3.1.2 | Our three key independent variables

1. A firm's quantity of environmental disclosure (*ENVDISC*)

Using the Bloomberg environmental disclosure score, we study how a firm's quantity of environmental disclosure (*ENVDISC*) influences its ex ante cost of equity via investors' perception of environmental risk. The environmental disclosure score obtained by Bloomberg represents the amount of environmental information a firm reveals to the public through its annual reports, sustainability reports, websites and other public sources. The prior literature has adopted the Bloomberg disclosure scores representing a company's transparency in ESG dimensions (Albarrak et al., 2018; Benlemlih et al., 2018; Siew et al., 2016; Tamimi & Sebastianelli, 2017). The Bloomberg environmental disclosure score simply measure the amount of environmental information a firm discloses to the public and does not evaluate its performance in the environmental dimension. The Bloomberg environmental disclosure score ranges from 0.1 to a maximum score of 100. A higher score indicates greater transparency. For instance, the highest value of 100 is for a firm that makes environmental information available for every data point gathered by Bloomberg. Examples of environmental metrics followed by Bloomberg are renewable energy usage, direct GHG emissions, indirect GHG emissions, waste disposal, water recycling, climate change policies and so on. We observe an average environmental disclosure score of 33.35 across our sample firms worldwide, while the median is 34.88 out of 100.

2. Country environmental performance

In this study, we adopt the country environmental performance index created by Wendling et al. (2018) as the indicator measuring a country's environmental performance in various environmental dimensions such as environmental policy, air quality, air pollution, climate, water resources, and efficient energy. The measure is constructed such that a country with a high score in the environmental performance index is doing well in environmental issues. We define the domicile country as a country where our sample firms' senior management locate.

3. A country's human development progress

Following the literature (Cai et al., 2016; Yu et al., 2020), we quantify a country's human development progress by adopting the country-specific HDI developed by the United Nations Development Programme (UNDP, 2018). The HDI from the United Nations measures a country's overall national well-being, rather than economic progress alone, such as GDP per capita. Each country in the HDI is evaluated in the following three dimensions equally: (a) a decent standard of living, (b) a healthy life and life expectancy and (c) knowledge and education attainment.

3.1.3 | Our control factors in this study

We collect the relevant macroeconomic and governance data at the country level from the World Bank and the IMF World Economic Outlook database. We also collect firms' company information (e.g. the country where a firm's senior management resides), other

environmental data for each firm (e.g. GHG emissions) and fundamental financial information from Thomson ASSET4 and Bloomberg. We discuss our key control variables below.

1. Our key control factors at firm level: BETA and SIGMA

In this study, we choose the sample firms from the MSCI ACWI and only focus on those which list their equities on more than one stock exchange. We quantify the sample firms' market risk using BETA and SIGMA (Chang & Jo, 2019; Chen et al., 2009; Ng & Rezaee, 2015). BETA represents how each of our sample firms responds to market movements and can be a proxy of systematic (non-diversifiable) risk. We estimate the beta value by regressing each sample firm's equity return against the return of the MSCI ACWI (representing the market portfolio) over 60 months. The value of SIGMA for each sample firm is estimated as the annualised deviation of the daily equity return over the last 260 trading days. We anticipate both control variables, BETA and SIGMA, to be positively associated with a firm's cost of equity in order to meet investors' expectations on the risk–return trade-off relationship.

2. Our key control factors at the country level

We use the indicator of voice and accountability (World Bank, 2018) as an alternative measure for a country's human development progress (HDI) index (UNDP, 2018). The indicator of voice and accountability gauges the extent to which a country's citizens have freedom of expression in their beliefs.

Following the prior literature (Jandhyala, 2013; Siegel et al., 2013), we also adopt similar control variables at the country level, including the World Bank's worldwide governance indicators (WGI) for representing the quality of a country's institutions. The six time-varying governance indicators (WGI) created by the World Bank are voice and accountability, government effectiveness, control of corruption, political ability and absence of violence, the rule of law and regulatory quality. In addition to controlling for the differences of economic development across countries, scholars in the CSR and finance literature often account for the influences of institutional qualities (Breuer et al., 2018; Cai et al., 2016; Del Bosco & Misani, 2016; Delmas & Burbano, 2011; Finney et al., 2011; Ioannou & Serafeim, 2012; Tashman et al., 2019). For example, Bui et al. (2019) document that companies that are more likely to reveal carbon information to the public located in better governed countries. Poor institutional quality at the country level is more likely to result in weaker institutional pressures on firms to achieve a satisfactory level of CSR disclosure and performance (Cai et al., 2016; Campbell, 2007; Ioannou & Serafeim, 2012; Marquis et al., 2016).

3.2 | A summary of all variables in our main model

In Table 2, we provide a detailed description and data sources of all variables included in this study. Overall, we obtain and merge data through multiple sources (e.g. Refinitiv Eikon, Thomson Reuters I/B/E/S and Bloomberg). Some variables are obtained through our own estimation (e.g. a firm's ex ante cost of equity).

Table 3 reports descriptive statistics of the key variables based on our full sample of 10,367 firm-year observations from 1481 firms in 43 countries and territories from 2013 to 2019. The mean of the ex ante cost of equity derived from the five valuation models is 0.1034, while the average environmental disclosure score is 33.35 out of the maximum score of 100.

Table 4 presents the correlations among the key variables. We observe that all pairwise correlation coefficients among these key control variables are less than 0.7, which eases our concern that multicollinearity may influence our following regressions (Bedeian, 2014). We can also see that the variable of Voice (World Bank, 2018) is a good alternative indicator for a country's human development progress (HDI) because of the relatively high correlation coefficient between the two (0.7352).

4 | RESULTS AND ANALYSIS

In this section, we empirically investigate how a firm's environmental disclosure influences its ex ante cost of equity, via investors' perception of risk. We also examine whether non-financial country-level factors can influence investors' perception of a firm's riskiness.

We start with our full sample which is composed of 10,367 firm-year observations from 1481 firms in 43 countries and territories from 2013 to 2019. As expected, with an international dataset covering developed and developing nations, we observe a considerable variation across countries (Table 5).

Table 5 shows a breakdown by 43 countries and territories for our two key variables: a country's average ex ante cost of equity and the average level of its environmental disclosure scores. Not surprisingly, the estimates of the ex ante cost of equity for firms domiciled in the EU are pretty similar. For instance, the average value of the ex ante cost of equity in France is 12.14%, Germany 12.64%, Netherlands 10.11%, Luxembourg 12.72% and Austria 12.93%. The average values of the ex ante cost of equity are higher for the sample firms domiciled in South Korea (21.12%) and Russia (19.04%). We note that most of our sample firms in South Korea rely heavily on debt rather than equity in their capital structure, and this high leverage might increase investors' perception of risk.

Table 6 presents summary statistics by industry. Among our 10 GICS sectors, the three sectors with the highest ex ante cost of equity are energy (11.82%), consumer discretionary (11.23%) and materials (11.18%). At the same time, the three sectors which disclose the greatest amounts of environmental information are materials (40.78), utilities (38.55) and energy (36.15).

We also observe that some variables are highly industry dependent as suggested by the literature. For example, scholars document that a firm's environmental disclosure, a firm's corporate social performance and a firm's financial indicators are highly industry dependent (Bebchuk et al., 2009; Breuer et al., 2018; Huang et al., 2018; Lu

TABLE 2 Definitions of variables and data source

Variable	Description	Data source
Key variables		
Indicator of the ex ante Cost of Equity COE_A	We take the average value of the ex ante cost of equity from the following five valuation models: Model 1 (Claus & Thomas, 2001), Model 2 (Ohlson & Juettner-Nauroth, 2005), Model 3 (Gebhardt et al., 2001), Model 4 (Easton, 2004) and Model 5 (forward earnings/price ratio) (Pinto, 2020). For more detailed information on how we estimate our sample firms' ex ante cost of equity, please refer to Appendix A	Authors' calculation. We collect equity analysts' forecasted information for each firm including the values of forecasted earnings per share from Thomson Reuters I/B/E/S available in Eikon
Indicator of the ex ante Cost of Equity COE_B	We take the average value of the ex ante cost of equity from the following four valuation models: Model 1 (Claus & Thomas, 2001), Model 2 (Ohlson & Juettner-Nauroth, 2005), Model 3 (Gebhardt et al., 2001) and Model 4 (Easton, 2004). For more detailed information on how we estimate our sample firms' ex ante cost of equity, please refer to Appendix A	Authors' calculation. Raw data from Thomson Reuters I/B/E/S available in Eikon
Indicator of the ex ante Cost of Equity COE_C	The ex ante cost of equity derived from (Model 5) forward earnings/price ratio (Pinto, 2020)	Authors' calculation. Raw data from Thomson Reuters I/B/E/S available in Eikon
ENVDISC: (Bloomberg environmental disclosure score/100)*We use the linear term and the quadratic term of (ENVDISC) in this study.	The proprietary Bloomberg environmental disclosure score quantifies the quantity of environmental data a firm discloses to the public. The minimum environmental score ranges from 0.1 to the maximum score of 100 for those firms that reveal all data points gathered by Bloomberg. In this study, we include the linear term and the quadratic term of this variable to allow for a possible non-linearity in our major equation	Bloomberg
GHG Intensity	The greenhouse gas intensity is calculated as the ratio of a firm's total greenhouse gas emissions divided by its sales revenue. We convert sales to a common currency, the US dollar, in order to compare all our sample firms around the world	Bloomberg
$\left(\frac{GHG\ Scope1}{EBITDA}\right)$	We use $\left(\frac{GHG\ Scope1}{EBITDA}\right)$ as the alternate indicator of *GHG Intensity*. GHG Scope 1 emissions are defined as the direct greenhouse gas emissions from sources possessed or managed by the firm. EDITDA is estimated as a firm's earnings before interest, taxes, depreciation and amortisation	Authors' calculation. Raw data from Bloomberg
A country's human development progress (HDI)	In this study, we use HDI representing a country's human development progress in order to capture overall national well-being. This index is a summary measure of achievements in the following three aspects: being knowledgeable, a healthy and long life and the quality of living standards	United Nations Development Programme (UNDP)

TABLE 2 (Continued)

Variable	Description	Data source
A country's environmental performance	In this study, we measure a country's environmental performance by adopting the country environmental performance index from Yale Centre for Environmental Law and Policy. The country environmental performance index (Wendling et al., 2018) is composed of 24 environmental performance indicators covering the following 10 dimensions: air pollution, air quality, water and sanitation, water resources, fisheries, climate and energy, heavy metals, biodiversity and habitat, forests and agriculture. Since this index is updated every other year, we adopt the data published in 2012, 2014, 2016 and 2018 for this study	Yale Centre for Environmental Law and Policy (YCELP)
Voice and accountability	In this study, we use this indicator as an alternative measurement for a country's human development progress. The indicator of voice and accountability measures perceptions of the extent to which a country's citizens have freedom of expression in their beliefs and are also given rights in electing their government	World Bank
Control factors at firm level		
Beta	BETA measures how each of our sample firms share price responds to market risk. In this study, we estimate the beta value by regressing each sample firm's equity return against the return of the MSCI World All Country Index (representing as a market portfolio) over 60 months	Authors' calculation. Raw data from Bloomberg
SIGMA	The value of SIGMA for each sample firm is calculated as the annualised standard deviation of daily equity return over the last 260 trading days	Authors' calculation. Raw data from Bloomberg
Market capitalisation	A firm's market value	Bloomberg
Leverage	A ratio of total debt to total assets	Bloomberg
Return on asset (ROA)	A ratio of net income to total assets	Bloomberg
R&D	A proportion of research and development expenses to net sales	Bloomberg
Institutional ownership	A proportion of shares held by institutional investors	Bloomberg
Insider ownership	A proportion of shares held by insiders	Bloomberg
Sales growth rate	A ratio of changes in sales from the prior year	
Control factors at country level		
Log (GDP per capita) measured based on PPP	Log (GDP per capita) is converted to the US dollar at purchasing power parity exchange rates	International Monetary Fund's World Economic Outlook Database
Institutional qualities	**Political stability and absence of violence**: This indicator measures perceptions of the possibility of political uncertainty or politically driven violence	World Bank
	Government effectiveness: This indicator quantifies the quality of a country's civil/public service and the trustworthiness of	World Bank

(Continues)

TABLE 2 (Continued)

Variable	Description	Data source
	a government's commitment to its policies	
	Regulatory quality: This indicator measures perceptions of a government to execute sensible policies that stimulate private sector development	World Bank
	The rule of law: This indicator measures perceptions of the extent to which agents have trust and accept the rules of society	World Bank
	Control of corruption: The indicator of voice and accountability measures perceptions of the extent to which a country's citizens have freedom of expression in their beliefs and are also given rights in electing their government	World Bank

Note: This table shows the definitions and data sources of all our variables in this study.

TABLE 3 Summary statistics of key variables

Variable	Mean	Std. Dev	Min	Median	Max
The ex ante Cost of Equity COE_A	0.1034	0.0600	0	0.0916	0.7911
The ex ante Cost of Equity COE_B	0.1169	0.0730	6.25E-05	0.1012	0.9833
The ex ante Cost of Equity COE_C	0.0640	0.0411	0	0.0561	0.9789
(Environmental disclosure/100)	0.3335	0.1785	0.0138	0.3488	0.9302
(GHG intensity/100)	4.4550	16.1810	0	0.5614	495.8765
(GHG Scope 1/EBITDA)	2.1756	9.6431	9.08E-07	0.1083	301.8090
(A country's environmental performance/100)	0.6958	0.1235	0.3057	0.6993	0.9068
A country's human development progress (HDI)	0.8841	0.0700	0.6000	0.9150	0.9540
(Voice/100)	0.7623	0.2260	0.0469	0.8227	1

Notes: This table reports the descriptive statistics of 10,367 firm-year observations from 1481 firms in 43 countries and territories from 2013 to 2019. We estimate the ex ante equity financing cost for our sample firms. For the indicator of the ex ante **Cost of Equity COE_A**, we take the average value of the implied cost of equity from the following five valuation models: Model 1 (Claus & Thomas, 2001), Model 2 (Ohlson & Juettner-Nauroth, 2005), Model 3 (Gebhardt et al., 2001), Model 4 (Easton, 2004) and Model 5 (forward earnings/price ratio) (Pinto, 2020). For the indicator of the ex ante **Cost of Equity COE_B**, we take the average value of the implied cost of equity from the following four valuation models: Model 1 (Claus & Thomas, 2001), Model 2 (Ohlson & Juettner-Nauroth, 2005), Model 3 (Gebhardt et al., 2001) and Model 4 (Easton, 2004). For the indicator of the ex ante **Cost of Equity COE_C**, the implied cost of equity derived from (Model 5) forward earnings/price ratio (Pinto, 2020). For more detailed information on how we estimate our sample firms' implied cost of equity, please refer to Appendix A.

et al., 2017; Miralles-Quirós et al., 2019). Therefore, we use sector dummies to control for industry heterogeneity by adopting the Global Industry Classification Standard (GICS). Following the prior international empirical studies, we control industries/year fixed effects and employ control variables at country level (Breuer et al., 2018; Cheng et al., 2014; Huang et al., 2018; Lu et al., 2017). To solve the heteroskedasticity and autocorrelation problems, we analyse our panel dataset using Panel EGLS cross-section weight with the White diagonal as our coefficient covariance method.

4.1 | Hypothesis 1: Empirical results

We find supporting evidence for Hypothesis 1. Our empirical results show that there is a non-linear relationship between a firm's environmental quantitative disclosure and its ex ante cost of equity. According to all models presented in Table 7, which uses the ex ante cost of equity COE_A as the dependent variable, we can see that the coefficients for the linear term and the quadratic term of a firm's environmental disclosure are statistically significant at 1% to the ex ante cost of equity. Our results suggest that a firm's greater environmental disclosure can initially decrease the ex ante cost of equity but then raises it once a certain threshold level of environmental disclosure is exceeded.

For robustness checks, we adopt two further measurements of a firm's ex ante cost of equity to replace the ex ante cost of equity COE_A: They are the ex ante cost of equity COE_B and the ex ante cost of equity COE_C.[2] The results shown in Table 8 are consistent with the previous results in Table 7 and confirm that a non-linear relationship exists between a firm's environmental disclosure and its ex ante cost of equity.

TABLE 4 Correlations coefficients among our key variables (full sample)

Variable	The ex ante Cost of Equity COE_B	The ex ante Cost of Equity COE_C	The ex ante Cost of Equity COE_A	(Environmental disclosure/100)	(GHG intensity/100)	(GHG Scope 1/EBITDA)	(A country's environmental performance/100)	(Voice/100)	A country'shuman development progress (HDI)
The ex ante Cost of Equity COE_C	0.2667*	1							
The ex ante Cost of Equity COE_A	0.9929*	0.3799*	1						
(Environmental disclosure/100)	0.0279	0.0565*	0.0338	1					
(GHG intensity/100)	−0.0369	0.0161	−0.0334	0.0640*	1				
(GHG Scope 1/EBITDA)	−0.0235	0.0215	−0.0199	0.0650*	0.4135*	1			
(A country's environmental performance/100)	0.0620*	−0.0049	0.0589*	0.0094	−0.0596*	−0.0189	1		
(Voice/100)	0.0796*	−0.0692*	0.0678*	−0.0937*	−0.0842*	−0.0333	0.4206*	1	
A country's human development progress (HDI)	0.0658*	−0.1009*	0.0507*	−0.0540*	−0.1128*	−0.0500*	0.5117*	0.7352*	1

Notes: The Pearson correlations between the key variables are presented above. We estimate the ex ante equity financing cost for our sample firms. For the indicator of the ex ante **Cost of Equity COE_A**, we take the average value of the implied cost of equity from the following five valuation models: Model 1 (Claus & Thomas, 2001), Model 2 (Ohlson & Juettner-Nauroth, 2005), Model 3 (Gebhardt et al., 2001), Model 4 (Easton, 2004) and Model 5 (forward earnings/price ratio) (Pinto, 2020). For the indicator of the ex ante **Cost of Equity COE_B**, we take the average value of the implied cost of equity from the following four valuation models: Model 1 (Claus & Thomas, 2001), Model 2 (Ohlson & Juettner-Nauroth, 2005), Model 3 (Gebhardt et al., 2001) and Model 4 (Easton, 2004). For the indicator of the ex ante **Cost of Equity COE_C**, the implied cost of equity derived from (Model 5) forward earnings/price ratio (Pinto, 2020). For more detailed information on how we estimate our sample firms' implied cost of equity, please refer to Appendix A.

*1% statistical significance level.

TABLE 5 Sample breakdown by 43 countries and territories

Country	Firm number	Mean of the ex ante cost of equity COE_A	Mean of environmental disclosure
New Zealand	5	0.0594	16.5822
Netherlands	10	0.1011	44.5664
Mexico	12	0.0834	38.1869
Malaysia	3	0.0602	19.9397
Luxembourg	4	0.1272	20.1878
Jordan	1	0.0764	22.0376
Japan	207	0.0797	40.6322
Italy	10	0.0895	51.1626
Israel	4	0.1075	19.8644
Ireland	5	0.1091	24.1037
Indonesia	21	0.0775	17.0773
India	3	0.0804	31.4565
Hungary	2	0.1002	43.3930
Hong Kong	62	0.0969	26.8430
Germany	48	0.1264	41.9683
France	53	0.1214	44.2686
Finland	11	0.0856	52.6388
Denmark	15	0.1235	33.7223
Colombia	3	0.0884	49.5425
Chile	6	0.0934	40.0014
China	80	0.1018	22.0915
Canada	50	0.1397	27.6721
Britain	63	0.1037	31.6507
Brazil	37	0.1179	44.2705
Belgium	7	0.1109	37.0827
Austria	3	0.1293	39.6990
Australia	43	0.0793	31.1060
Portugal	3	0.0753	54.9649
Portland	11	0.1384	27.9788
Philippines	15	0.0782	23.3786
Peru	1	0.0930	7.5305
Norway	8	0.0904	41.5004
Unites States	508	0.1087	28.0945
Turkey	13	0.1192	34.9136
Thailand	23	0.0809	39.2372
Taiwan	6	0.0745	58.9976
Switzerland	25	0.1420	42.2973
Sweden	21	0.0937	39.2048
Spain	14	0.0920	51.3201
South Korea	6	0.2112	32.2727
South Africa	32	0.1087	32.3233
Singapore	18	0.0812	26.8252
Russia	9	0.1904	30.4556
Full sample	1481	0.1034	33.3549

Notes: This table presents the country distributions for the observations comprising our sample between 2013 and 2019. Our international dataset is composed of 10,367 firm-year observations from 1481 firms in 43 countries and territories. We estimate the ex ante equity financing cost for our sample firms. For each country, the average estimation of the ex ante cost of equity of all sample firms in that country represents the country's ex ante cost of

equity. For the indicator of ex ante **Cost of Equity COE_A**, we take the average value of the ex ante cost of equity from the following five valuation models: Model 1 (Claus & Thomas, 2001), Model 2 (Ohlson & Juettner-Nauroth, 2005), Model 3 (Gebhardt et al., 2001), Model 4 (Easton, 2004) and Model 5 (forward earnings/price ratio) (Pinto, 2020). The proprietary Bloomberg environmental disclosure score quantifies the quantity of environmental data a firm discloses to the public. The minimum environmental score ranges from 0.1 to the maximum score of 100 for those firms that reveal all data points gathered by Bloomberg.

TABLE 6 Summary statistics by industry

		The ex ante Cost of Equity COE_A		Environmental disclosure	
Sector	Firm number	Mean	Median	Mean	Median
Consumer discretionary	267	0.1123 (0.0696)	0.0972	29.5351 (17.6804)	28.6822
Consumer staples	146	0.0976 (0.0596)	0.0866	34.6701 (16.8497)	37.2093
Energy	111	0.1182 (0.0499)	0.1109	36.1561 (19.9656)	37.2093
Healthcare	134	0.0918 (0.0582)	0.0818	30.6849 (18.3278)	31.7829
Industrials	271	0.1015 (0.0559)	0.091	32.7726 (16.5694)	33.3333
Information technology	159	0.0981 (0.062)	0.0866	31.9499 (19.7649)	33.3333
Materials	139	0.1118 (0.0608)	0.1007	40.7838 (17.1790)	43.4109
Real estate	95	0.0906 (0.0588)	0.0753	27.9463 (15.4655)	31.0078
Telecommunication services	61	0.1003 (0.0579)	0.089	32.9937 (14.5289)	34.8837
Utilities	98	0.1043 (0.0430)	0.0958	38.5535 (16.4904)	41.0853
Full sample	1481	0.1034 (0.0600)	0.0916	33.3549 (17.8465)	34.8837

Notes: Standard deviations are reported in parentheses. Our dataset is composed of 10,367 firm-year observations from 1481 firms in 43 countries and territories. In this study, we cluster our sample firms into 10 GICS sectors. We leave out financial services companies since financial and banking regulations may influence a firm's disclosure policy. We estimate the ex ante equity financing cost for our sample firms. For the indicator of the ex ante **Cost of Equity COE_A**, we take the average value of the ex ante cost of equity from the following five valuation models: Model 1 (Claus & Thomas, 2001), Model 2 (Ohlson & Juettner-Nauroth, 2005), Model 3 (Gebhardt et al., 2001), Model 4 (Easton, 2004) and Model 5 (forward earnings/price ratio) (Pinto, 2020). The proprietary Bloomberg environmental disclosure score quantifies the quantity of environmental data a firm discloses to the public. The minimum environmental score ranges from 0.1 to the maximum score of 100 for those firms that reveal all data points gathered by Bloomberg.

Furthermore, we visualise this relation between a firm's quantitative environmental disclosure and its ex ante cost of equity through Figure 1 by using the regression results of Model 3 presented in Table 7.

In Figure 1, we estimate the turning point for a firm's environmental disclosure score as 84.6 out of a maximum score of 100. At the turning point, a firm's corresponding ex ante cost of equity is 6.44%. Figure 1 clearly shows that most of our sample firms can keep on moving towards the minimum ex ante cost of equity (the turning point) by revealing greater quantities of environmental information to the public. In this study, the mean (median) of the environmental disclosure score for all our sample firms is 33.3549 (34.8837). Most of our sample firms' environmental disclosure benefits outweigh their environmental disclosure costs.

In Figure 2, we visualise how our sample countries distribute around this U-shaped curve using the same regression results of Model 3 in Table 7. Since the mean of the environmental disclosure by countries ranges from 10 to 60 (out of the maximum score of 100), all our sample countries are actually located on the left-hand side of the turning point. This may explain why most of the previous studies in CSR/environmental literature obtain a negative linear relationship (Breuer et al., 2018; Bui et al., 2019; Matsumura et al., 2014), although our empirical results show that the ex ante cost of equity will then increase once the environmental disclosure score exceeds 84.6.

Our results support Hypothesis 1. Similar to the CSR literature's findings that more investment in CSR cannot enhance shareholders' value without a limit (Barnea & Rubin, 2010; Borghesi et al., 2014; Trumpp & Guenther, 2017), we find empirical evidence for a non-linear (quadratic) relationship between an MNC's environmental quantitative disclosure and its ex ante cost of equity. Our empirical evidence supports the rationale for this non-linear relation mentioned in the previous section. Initially, a lessening of the investors' information asymmetry lowers the required risk premium via a reduction in perceived environmental risks, that is, the transparency gain far outweighs the costs of disclosure. Once the environmental data disclosed exceed a certain threshold, the marginal benefits obtained from greater transparency may fall below the marginal costs arising from closer scrutiny by investors.

Finally, our empirical evidence for Hypothesis 1 also shows that a firm's environmental quantitative disclosure is value relevant to the investors, supporting a similar view in the prior literature (Albarrak et al., 2018; Dhaliwal et al., 2011).

4.2 | Hypothesis 2: Empirical results

In Hypothesis 2, we investigate whether an MNC can benefit from a reduced ex ante cost of equity if it moderates high GHG intensity by increasing environmental disclosure in the subsequent year. We examine this joint effect by using the interaction term of a firm's environmental disclosure and its GHG intensity,

TABLE 7 Regression results for all sample firms, the ex ante Cost of Equity COE_A, 2013–2019

		Model 1	Model 2	Model 3	Model 4
		The ex ante Cost of Equity COE_A	The ex ante Cost of Equity COE_A	The ex ante Cost of Equity COE_A	The ex ante Cost of Equity COE_A
Hypothesis 1	(Environmental disclosure/100; t-1)	−0.4180*** (−7.1787)	−0.2652*** (−7.6301)	−0.1852*** (−4.5890)	−0.0539*** (−5.1327)
	(Environmental disclosure/100; t-1)^ 2	0.0750*** (4.5868)	0.0666*** (5.2183)	0.1094*** (11.9410)	0.0693*** (5.2945)
Hypothesis 2	(Environmental disclosure/100, t-1)* (GHG intensity; t-2)		−0.0005*** (−4.1182)		−0.0005*** (−3.8661)
	(Environmental disclosure/100, t-1)* (GHG Scope 1/EBITDA; t-2)	−0.0004*** (−3.2170)		−0.0001 (−1.7383)	
Hypothesis 3a	(A country's environmental performance/100; t-1)	−0.0163** (−1.9739)	−0.0248*** (−3.5702)	−0.0256*** (−4.9286)	−0.0256*** (−3.7334)
Hypothesis 3b	(A country's human development progress; t-1)	−0.6116*** (−13.1174)	−0.1181*** (−5.564)	−0.0141*** (−0.4.1093)	−0.0685*** (−3.8652)
	Control variables-firm level				
	Beta at firm level; t	0.0025*** (2.5845)	0.0048*** (6.2102)	0.0046*** (6.9756)	0.0049*** (6.3712)
	(Volatility/100) at firm level; t	0.0852*** (15.1915)	0.0437*** (9.6565)	0.0517*** (11.7494)	0.0418*** (9.1855)
	(GHG intensity; t-1) at firm level		4.51E-07** (2.4680)		0.0000* (1.7776)
	(GHG Scope 1/EBITDA; t-1) at firm level	−6.38E-05 (−0.9591)		−9.22E-06 (−0.9387)	
	Log (market capitalization) at firm level; t-1	0.0092*** (21.5986)	0.0097*** (26.235)	−0.0002 (−0.7799)	0.01*** (27.5337)
	(Leverage/100) at firm level; t-1	0.0476*** (15.7377)	0.0617*** (23.3807)	0.0040** (2.1848)	0.061*** (22.9986)
	(R&D intensity/100) at firm level; t-1	0.0195* (1.8370)	−0.0305*** (−4.0311)	−0.0248*** (−3.7432)	−0.029*** (−3.4548)
	(ROA/100) at firm level; t-1		0.0302*** (4.6525)	−0.0181*** (−3.7605)	0.034*** (5.2416)
	the growth rate of ROA; t-1	0.0020 (1.1680)			
	(current ratio/100) at firm level; t-1	−0.4322*** (−8.3774)	−0.2739*** (−8.0144)	−0.2779*** (−9.1402)	−0.2667*** (−7.9697)
	(sales growth/100) at firm level; t-1	−0.0088*** (−2.9002)	−0.0062*** (−3.1885)	−0.0042*** (−3.6756)	−0.0064*** (−3.2423)
	Environmental disclosure growth; t-1	0.0007 (0.4335)	3.39E-05 (0.0222)	0.0006 (1.3418)	−0.0003 (−0.2006)
	Log (board size) at firm level; t-1	0.0191*** (9.7227)	0.0121*** (8.9126)	0.0130*** (12.7813)	0.0129*** (9.3786)
	(Insider/100); t-1	−0.1941*** (−5.6734)	−0.0078 (−0.5903)	−0.0455* (−1.9495)	−0.0147 (−0.818)
	(Environmental disclosure/100; t-1)* (Insider/100; t-1)	0.3734*** (4.3183)	0.0221 (0.5435)	0.0566 (0.9509)	0.041 (0.8462)
	(Institutional investors/100; t-1)	−0.0121*** (−6.5481)	−0.0024 (−1.5596)	0.0007 (0.5667)	−0.0018 (−1.2086)
	Control variables-country level				
	(Environmental disclosure/100; t-1)* (a country's human development progress; t-1)	0.5574*** (7.8148)	0.2411*** (6.5285)	0.1181*** (2.7516)	
	Log (GDP per capita) at home country; t-1	0.0555*** (16.7483)			

TABLE 7 (Continued)

	Model 1	Model 2	Model 3	Model 4
(Political stability/100); t-1	−0.0142*** (−3.6102)	−0.0291*** (−8.8723)	−0.0054** (−2.2085)	−0.0239*** (−7.1732)
(Regulatory quality/100) at home country; t-1	0.0056 (0.4908)	0.0015 (0.1719)	0.0359*** (4.9333)	0.0053 (0.6045)
(Law/100) at home country; t-1	0.0496*** (2.8770)	0.0833*** (5.8222)	0.0377*** (2.8730)	0.0736*** (5.3134)
(Control of Corruption/100) at home country; t-1	0.0513*** (4.1652)	0.0303** (2.5357)	0.0007 (0.0650)	0.0472*** (4.2695)
(Environmental disclosure/100; t-1)* (Government effectiveness/100; t-1)	−0.1643*** (−6.3898)		−0.0438*** (−4.1880)	
(Government effectiveness/100; t-1)		−0.0771*** (−7.0969)		−0.0796*** (−6.9621)
Constant	−0.1634*** (−5.8022)	0.0817*** (4.1858)	0.1428*** (6.5853)	0.022 (1.5307)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Observations	10,367	10,367	10,367	10,367
Adjusted R^2	0.6165	0.4903	0.4208	0.4844

Notes: $COE_{i,t} = \alpha + \beta_1(ENVDISC_{t-1}) + \beta_2 * (ENVDISC_{t-1})^2 + \beta_3 * (ENVDISC_{t-1} * GHG\ Intensity_{t-2}) + \beta_4 * [GHG\ Intensity\ or\ (GHG\ Scope1/EBITDA)]_{t-1} + \beta_5 * (country\ environmental\ performance) + \beta_6 * (HDI)_{t-1} + \sum \gamma * Control_{ijt} + \sum \tau_m * Industry_m + \sum \omega_k Year_k + \varepsilon_{it}$. We estimate the ex ante equity financing cost for our sample firms. For the indicator of the ex ante **Cost of Equity** $\boldsymbol{COE_A}$, we take the average value of the ex ante cost of equity from the following five valuation models: Model 1 (Claus & Thomas, 2001), Model 2 (Ohlson & Juettner-Nauroth, 2005), Model 3 (Gebhardt et al., 2001), Model 4 (Easton, 2004) and Model 5 (forward earnings/price ratio) (Pinto, 2020). For more detailed information on how we estimate our sample firms' ex ante cost of equity, please refer to Appendix A. Robust *t*-statistics are reported in parentheses. Our dataset is composed of 10,367 firm-year observations from 1481 firms in 43 countries and territories from 2013 to 2019. We analyse our panel dataset by Panel EGLS cross-sectional weight with the white diagonal as our coefficient covariance method.

*Significance at 10% level.

**Significance at 5% level.

***Significance at 1% level.

($ENVDISC_{t-1} * GHG_{t-2}$).[3] For detailed information on our variables' estimation methods and their definitions, please refer to Table 2.

Based on Tables 7 and 8, most of our models show that there is a consistent and negative association between a firm's ex ante cost of equity and this joint effect. The statistical significance levels of this joint effect range between 1% and 10%. The joint effect can be interpreted as the moderation impact of a firm disclosing large quantities of environmental information retrospectively, thereby decreasing the risk premium required by potential investors, even if it had high greenhouse intensity in the previous year. Investors are willing to reduce their required risk premium because their information asymmetry is reduced by receiving increased environmental disclosure from the firm.

In addition to examining this joint effect, we also investigate the direct effect of a firm's GHG intensity on its ex ante cost of equity. Our empirical results in Tables 7 and 8 show that a firm's GHG intensity, which is measured either by using the variable of GHG_{t-2} or the alternative variable ($GHG\ Scope\ 1_{t-1}/EBITDA_{t-1}$) has no significant effect on the ex ante cost of equity. Our empirical evidence on the direct effect, which is in line with the previous studies (Li et al., 2014), implies that a firm with a higher GHG intensity is not generally penalised by investors. Our findings on the variable GHG intensity suggest that investors do not view a firm's GHG intensity in isolation, but rather in association with its disclosed environmental information available to the public.

4.3 | Hypothesis 3a: Empirical results

In Hypothesis 3a, we examine whether an MNC's domicile country environmental performance can impact its ex ante cost of equity via changing investors' risk perception. We define the domicile country as the country where a firm's senior management resides. Tables 7 and 8 show supporting evidence for Hypothesis 3a across all our models. The coefficients of the country environmental performance are consistently negative and significant at 1%–5% levels. Our regression results suggest that investors perceive a firm domiciled in a country with a better country environmental performance to be less risky. The empirical findings support our rationale for Hypothesis 3a. A country with a better country environmental performance can be considered as a better environmental business environment. It provides better environmental policies and schemes to help companies achieve better environmental performance. Due to the potential reduction of pollution, legal costs and environmental fines in the future, a greater production efficiency or a positive cash flow impact can be predicted.

TABLE 8 Regression results for all sample firms, Cost of Equity COE_B and Cost of Equity COE_C, 2013–2019

		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
		The ex ante Cost of Equity COE_B	The ex ante Cost of Equity COE_B	The ex ante Cost of Equity COE_C	The ex ante Cost of Equity COE_C	The ex ante Cost of Equity COE_C	The ex ante Cost of Equity COE_B	The ex ante Cost of Equity COE_C
Hypothesis 1	(Environmental disclosure/100; t-1)	−0.4444*** (−9.5627)	−0.4379*** (−8.8698)	−0.2293*** (−5.1394)	−0.1831*** (−5.7739)	−0.245*** (−5.6744)	−0.0548*** (−4.3524)	−0.041*** (−6.3873)
	(Environmental disclosure/100; t-1)^2	0.0579*** (3.9139)	0.0531*** (3.3961)	0.1058*** (11.6375)	0.0585*** (7.216)	0.1041*** (11.3376)	0.0641*** (4.1096)	0.0647*** (8.1809)
Hypothesis 2	(Environmental disclosure/100, t-1)*(GHG intensity; t-2)	−0.0005*** (−3.2257)	−0.0002* (−1.7097)		−0.0002** (−2.3636)		−0.0005*** (−3.1631)	−0.0002** (−2.3159)
	(Environmental disclosure/100, t-1)*(GHG Scope 1/EBITDA; t-2)			−0.0001 (−1.6147)		−0.0003*** (−5.7375)		
Hypothesis 3a	(A country's environmental performance/100; t-1)	−0.0177** (−2.1323)	−0.0279*** (−3.2811)	−0.0289*** (−5.8155)	−0.0289*** (−7.0913)	−0.0159*** (−3.5929)	−0.0235*** (−2.862)	−0.0282*** (−6.9587)
Hypothesis 3b	(A country's human development progress; t-1)	−0.2985*** (−9.2319)	−0.2736*** (−8.1809)	−0.0793*** (−2.7556)	−0.0779*** (−3.9003)	−0.0553*** (−2.6847)	−0.0592*** (−2.8726)	−0.0265** (−2.5229)
	Control variables-firm level							
	Beta at firm level; t	0.0042*** (4.495)	0.0041*** (4.1692)	0.0045*** (6.9530)	0.0057*** (10.6399)	0.004*** (6.3673)	0.0038*** (4.1683)	0.0058*** (11.0518)
	(Volatility/100) at firm level; t	0.0565*** (10.3885)	0.0547*** (9.3909)	0.0517*** (11.6458)	0.0483*** (13.4368)	0.0542*** (12.058)	0.0577*** (10.3506)	0.0484*** (13.5114)
	(GHG intensity; t-1) at firm level	2.80E-07 (0.9387)	2.42E-07 (0.8391)		1.44E-07 (0.5381)		0.0000 (0.6159)	0.0000 (0.2424)
	(GHG Scope 1/EBITDA; t-1) at firm level			−7.30E-06 (−0.7952)		4.21E-06 (0.4202)		
	Log (market capitalization) at firm level; t-1	0.0114*** (25.406)	0.0118*** (26.3195)	−0.0004 (−1.5215)	−0.0005** (−2.0898)	−0.0003 (−1.2509)	0.0119*** (26.8854)	−0.0002 (−0.8264)
	(Leverage/100) at firm level; t-1	0.0775*** (25.2611)	0.0716*** (23.261)	0.0041** (2.2276)	0.0057*** (3.8154)	0.0049*** (2.7371)	0.0773*** (25.1515)	0.006*** (3.9909)
	(R&D intensity/100) at firm level; t-1	0.0162 (1.5595)	0.031*** (2.771)	−0.0260*** (−3.9133)	−0.0412*** (−6.7194)	−0.0152** (−2.2765)	0.0229** (2.1431)	−0.0429*** (−7.0633)
	(ROA/100) at firm level; t-1	0.0184** (2.4157)	-1.46E-05 (−0.813)	−0.0200*** (−4.0715)	−0.0051 (−1.3511)	−0.0363*** (−7.9791)	0.0222*** (2.904)	−0.0043 (−1.1552)
	the growth rate of ROA; t-1							
	(current ratio/100) at firm level; t-1	−0.2664*** (−7.2531)	−0.3228*** (−8.336)	−0.2482*** (−8.3521)	−0.3377*** (−15.8692)	−0.239*** (−8.0181)	−0.2631*** (−7.0699)	−0.3529*** (−16.3346)
	(sales growth/100) at firm level; t-1	−0.0081*** (−3.4974)	−0.0116*** (−3.965)	−0.0049*** (−4.5448)	−0.0043*** (−3.1283)	−0.004*** (−3.4031)	−0.0084*** (−3.4415)	−0.0039*** (−2.8276)
	Environmental disclosure growth; t-1	0.0017* (1.9354)	0.0014 (1.48)	0.0006 (1.4002)	−0.0017* (−1.9256)	0.0008 (1.5333)	0.0007 (0.6828)	−0.0015* (−1.8467)
	Log (board size) at firm level; t-1	0.0123*** (7.4636)	0.0122*** (7.1884)	0.0129*** (12.8203)	0.0095*** (10.6246)	0.0126*** (12.8295)	0.0129*** (7.8235)	0.0091*** (10.104)

TABLE 8 (Continued)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
(Insider/100); t-1	0.0266 (0.7622)	0.0643* (1.9002)	−0.0379 (−1.6078)	−0.0307*** (−2.8122)	−0.0336 (−1.3941)	0.0219 (0.6235)	−0.0227** (−2.1881)
(Environmental disclosure/100; t-1)* (Insider/100; t-1)	0.0014 (0.0172)	−0.0595 (−0.7289)	0.0373 (0.6205)	0.0107 (0.3319)	0.0329 (0.5472)	0.0212 (0.2497)	−0.0087 (−0.276)
(Institutional investors/100; t-1)	−0.0019 (−1.0759)	−0.002 (−1.0904)	0.0001 (0.1249)	−0.0013 (−1.3756)	0.0021* (1.7599)	−0.0014 (−0.7866)	−0.0008 (−0.8531)
Control variables-country level							
(Environmental disclosure/100; t-1)* (a country's human development progress; t-1)	0.6851*** (10.4208)	0.6735*** (9.5805)	0.2517*** (4.4664)	0.2066*** (4.6807)	0.2026*** (3.9766)		
Log (GDP per capita) at home country; t-1			−0.0060*** (−3.2497)				
(Political stability/100); t-1	−0.0369*** (−9.7609)	−0.0368*** (−9.3964)	−0.0080*** (−3.3226)	−0.0053*** (−2.4227)	−0.0057** (−2.4067)	−0.0298*** (−7.6358)	−0.0046** (−2.1219)
(Regulatory quality/100) at home country; t-1	−0.0072 (−0.7043)	−0.0061 (−0.5603)	0.0350*** (4.9677)	0.0191*** (3.2682)	−0.0061 (−0.5603)	−0.0058 (−0.5507)	0.0217*** (3.7349)
(Law/100) at home country; t-1	0.1297*** (7.5261)	0.1278*** (7.1686)	0.0252*** (2.0082)	−0.0142 (−1.3142)	0.1278*** (7.1686)	0.1165*** (7.0361)	−0.0283** (−2.5647)
(Control of Corruption/100) at home country; t-1	0.0215 (1.4929)	0.0178 (1.2022)	−0.0044 (−0.4177)	0.0218*** (2.5371)	0.0178 (1.2022)	0.0437*** (3.1395)	0.0224** (2.5352)
(Environmental disclosure/100; t-1)* (Government effectiveness/100; t-1)	−0.2429*** (−9.2386)	−0.2348*** (−8.4968)	−0.0809*** (−4.2019)	−0.042*** (−2.5259)	−0.0171 (−1.3607)		
(Government effectiveness/100; t-1)						−0.1112*** (−8.1452)	0.006 (0.7968)
Constant	0.1315*** (5.4315)	0.1192*** (4.701)	0.1292*** (5.6925)	0.1181*** (5.2995)	0.0782*** (4.0926)	0.0022 (0.1422)	0.0745*** (4.2754)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,367	10,367	10,367	10,367	10,367	10,367	10,367
Adjusted R^2	0.4802	0.4926	0.3844	0.3661	0.4128	0.4694	0.3854

Notes: $COE_{i,t} = \alpha + \beta_1(ENVDISC_{t-1}) + \beta_2 * (ENVDISC_{t-1})^2 + \beta_3 * (ENVDISC_{t-1} * GHG\ Intensity_{t-2}) + \beta_4 * [GHG\ Intensity\ or\ (GHG\ Scope1/EBITDA)]_{t-1} + \beta_5 * (country\ environmental\ performance) + \beta_6 * (HDI)_{t-1} + \sum \gamma * Control_{ijt} + \sum \tau_m * Industry_m + \sum \omega_k Year_k + \varepsilon_{it}$. We estimate the ex ante equity financing cost for our sample firms. For the indicator of the ex ante **Cost of Equity COE_B**, we take the average value of the ex ante cost of equity from the following four valuation models: Model 1 (Claus & Thomas, 2001), Model 2 (Ohlson & Juettner-Nauroth, 2005), Model 3 (Gebhardt et al., 2001) and Model 4 (Easton, 2004). For the indicator of the ex ante **Cost of Equity COE_C**, the ex ante cost of equity derived from (Model 5) forward earnings/price ratio (Pinto, 2020). For more detailed information on how we estimate our sample firms' ex ante cost of equity, please refer to Appendix A. Robust *t*-statistics are reported in parentheses. Our dataset is composed of 10,367 firm-year observations from 1481 firms in 43 countries and territories from 2013 to 2019. We analyse our panel dataset by Panel EGLS cross-sectional weight with the white diagonal as our coefficient covariance method.

*Significance at 10% level.

**Significance at 5% level.

***Significance at 1% level.

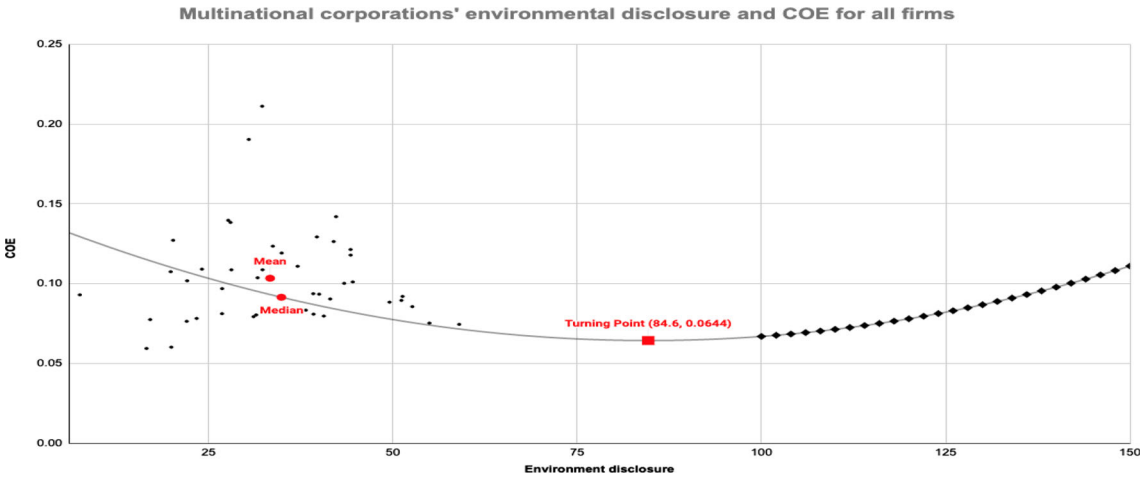

FIGURE 1 Multinational corporations' environmental disclosure and cost of equity for all firms.
Source: authors' own elaboration. Our dataset is comprised of 10,367 firm-year observations from 1481 firms in 43 countries and territories from 2013 to 2019. The 43 dots represent the average cost of equity and average environment score for all companies by country/territory. We use the regression results from Model 3 presented in Table 7. The minimum environmental score ranges from 0.1 to the maximum score of 100 for those firms that reveal all data points gathered by Bloomberg. For the Indicator of **Cost of Equity *COE*** $_A$, we take the average value of the implied cost of equity from the following five valuation models: (Model 1) Claus and Thomas (2001), (Model 2) Ohlson and Juettner-Nauroth (2005), (Model 3) Gebhardt et al. (2001), (Model 4) Easton (2004), and (Model 5) forward earnings price ratio (Pinto, 2020) [Colour figure can be viewed at wileyonlinelibrary.com]

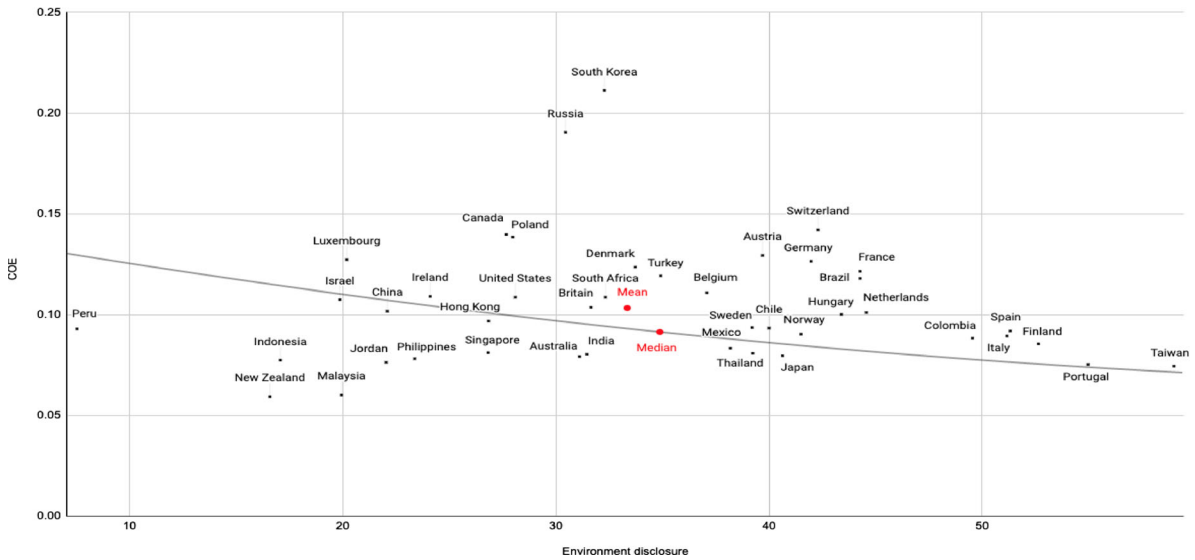

FIGURE 2 A breakdown by 43 countries and territories.
Source: authors' own elaboration. Our dataset is comprised of 10367 firm-year observations from 1481 firms in 43 countries and territories from 2013 to 2019. The 43 dots represent the average cost of equity and average environment score for all companies by country/territory. We use the regression results from Model (3) presented in Table 7. The minimum environmental score ranges from 0.1 to the maximum score of 100 for those firms that reveal all data points gathered by Bloomberg. For the Indicator of **Cost of Equity *COE*** $_A$, we take the average value of the implied cost of equity from the following five valuation models: (Model 1) Claus and Thomas (2001), (Model 2) Ohlson and Juettner-Nauroth (2005), (Model 3) Gebhardt et al. (2001), (Model 4) Easton (2004), and (Model 5) forward earnings price ratio (Pinto, 2020) [Colour figure can be viewed at wileyonlinelibrary.com]

Consequently, investors require less risk premium and therefore lower the cost of equity. Our empirical results also indicate that investors price a country's environmental performance in their investment process.

Moreover, our results for Hypothesis 3 are meaningful in economic terms. By using Model 3 in Table 7, we find that, all else equal, a one standard deviation increase in a domicile country's environmental performance can reduce a firm's ex ante cost of equity by 0.0031.[4] Since the mean of the ex ante cost of equity for our sample firms is 10.34%, this corresponds to about a 3.05% decrease[5] in the ex ante cost of equity, which is an economically significant effect.

TABLE 9 Regression results for all sample firms, 2013–2019 (Voice as the alternative indicator of HDI)

		Model 1	Model 2	Model 3	Model 4
		The ex ante Cost of Equity COE_A	The ex ante Cost of Equity COE_B	The ex ante Cost of Equity COE_C	The ex ante Cost of Equity COE_C
Hypothesis 1	(Environmental disclosure/100; t-1)	−0.1191*** (−4.7959)	−0.1069*** (−3.5760)	−0.0649*** (−5.0767)	−0.0503*** (−7.6189)
	(Environmental disclosure/100; t-1)^2	0.0841*** (5.0234)	0.0803*** (4.1259)	0.0646*** (8.0891)	0.0664*** (8.2415)
Hypothesis 2	(Environmental disclosure/100, t-1)* (GHG intensity; t-2)			−0.0003*** (−2.6703)	−0.0003*** (−2.7477)
	(Environmental disclosure/100, t-1)* (GHG Scope 1/EBITDA; t-2)	−0.0003*** (−3.0436)	−0.0003** (−2.4836)		
Hypothesis 3a	(A country's environmental performance; t-1)	−0.0411*** (−5.2423)	−0.0382*** (−4.1510)	−0.0200*** (−4.4414)	−0.0189*** (−4.1753)
Hypothesis 3b	(Voice/100; t-1)	−0.0237*** (−2.6079)	−0.0332*** (−3.1374)	−0.0482*** (−7.7419)	−0.0002*** (−7.9354)
	Control variables-firm level				
	Beta at firm level; t	0.0008 (0.9320)	0.0002 (0.2090)	0.0075*** (14.1418)	0.0075*** (13.1385)
	(Volatility/100) at firm level; t	0.0765*** (13.9315)	0.0950*** (14.1140)	0.0495*** (12.744)	0.0494*** (12.8509)
	(GHG intensity; t-1) at firm level			2.61E-07 (1.2745)	0.0000 (1.1693)
	(GHG Scope 1/EBITDA; t-1) at firm level	−7.87E-05* (−1.6469)	−7.11E-05 (−1.0013)		
	Log (market capitalization) at firm level; t-1	0.0089*** (21.1952)	0.0107*** (21.2332)	−0.0002 (−0.95)	0.0001 (0.3362)
	(Leverage/100) at firm level; t-1	0.0568*** (17.4270)	0.0766*** (19.3462)	0.0127*** (9.4337)	0.0122*** (7.4552)
	(R&D intensity/100) at firm level; t-1	−0.0116 (−1.2682)	0.0163 (1.3307)	−0.0354*** (−5.6051)	−0.0353*** (−5.6667)
	(ROA/100) at firm level; t-1	0.0320*** (4.1878)	0.0212** (2.2414)		
	the growth rate of ROA; t-1			0.0001*** (10.3234)	0.0111*** (8.698)
	(current ratio/100) at firm level; t-1	−0.2860*** (−6.2495)	−0.2421*** (−4.6705)	−0.2981*** (−13.2687)	−0.3095*** (−13.3245)
	(sales growth/100) at firm level; t-1	−0.0048* (−1.8259)	−0.0021 (−1.2826)	−0.0089*** (−7.422)	−0.008*** (−6.1195)
	Environmental disclosure growth; t-1	0.0015 (0.9796)	0.0025 (1.5136)	−0.0014** (−2.2006)	−0.0014** (−2.3398)
	Log (board size) at firm level; t-1	0.0229*** (12.6018)	0.0264*** (12.2338)	0.0113*** (13.32)	0.0113*** (13.2579)
	(Insider/100); t-1	−0.1571*** (−3.9997)	−0.1985*** (−4.1537)	−0.0161* (−1.7844)	−0.0103 (−1.146)
	(Environmental disclosure/100; t-1)* (Insider/100; t-1)	0.2973*** (3.0766)	0.4038*** (3.4472)	−0.002 (−0.0697)	−0.014 (−0.4999)
	(Institutional investors/100; t-1)	−0.0081*** (−4.3887)	−0.0095*** (−4.3101)	0.0007 (0.7403)	0.0007 (0.7304)
	Control variables-country level				
	(Environmental disclosure/100; t-1)* (Voice/100; t-1)	0.1121*** (5.8674)	0.1513*** (6.7208)	0.0719*** (5.2286)	
	Log (GDP per capita) at home country; t-1	0.0188*** (8.6993)	0.0254*** (10.0547)	−0.0075*** (−5.7117)	−0.0076*** (−5.9053)

(Continues)

TABLE 9 (Continued)

	Model 1	Model 2	Model 3	Model 4
	The ex ante Cost of Equity COE_A	The ex ante Cost of Equity COE_B	The ex ante Cost of Equity COE_C	The ex ante Cost of Equity COE_C
(Political stability/100); t-1	−0.0201*** (−5.5822)	−0.0163*** (−3.8855)	−0.0078*** (−3.6513)	−0.0057*** (−2.671)
(Regulatory quality/100) at home country; t-1	−0.0512*** (−5.0547)	−0.0885*** (−7.0734)	0.0334*** (5.81)	0.0329*** (5.6434)
(Law/100) at home country; t-1	0.0117 (0.7229)	0.0305 (1.6134)	0.0244** (2.1723)	0.0146 (1.2921)
(Control of Corruption/100) at home country; t-1	0.0340*** (2.6700)	0.0437*** (2.8638)	0.0089 (1.0488)	0.0201** (2.3299)
(Environmental disclosure/100; t-1) *(Government effectiveness/100; t-1)	−0.0552** (−2.4982)	−0.1091*** (−4.0486)	−0.0476*** (−3.4127)	−0.0227*** (−2.8864)
Constant	−0.1871*** (−9.9525)	−0.2695*** (−12.2403)	0.1189*** (7.6201)	0.1149*** (6.2809)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Observations	10,367	10,367	10,367	10,367
Adjusted R^2	0.4296	0.4269	0.6724	0.5220

Notes: $COE_{i,t} = \alpha + \beta_1(ENVDISC_{t-1}) + \beta_2 * (ENVDISC_{t-1})^2 + \beta_3 * (ENVDISC_{t-1} * GHG\ Intensity_{t-2}) + \beta_4 * [GHG\ Intensity\ or\ (GHG\ Scope1/EBITDA)]_{t-1} + \beta_5 * (country\ environmental\ performance) + \beta_6 * (Voice)_{t-1} + \sum \gamma * Control_{ijt} + \sum \tau_m * Industry_m + \sum \omega_k Year_k + \varepsilon_{it}$. We estimate the ex ante equity financing cost for our sample firms. For the indicator of the ex ante **Cost of Equity COE_A**, we take the average value of the ex ante cost of equity from the following five valuation models: Model 1 (Claus & Thomas, 2001), Model 2 (Ohlson & Juettner-Nauroth, 2005), Model 3 (Gebhardt et al., 2001), Model 4 (Easton, 2004) and Model 5 (forward earnings/price ratio) (Pinto, 2020). For the indicator of the ex ante **Cost of Equity COE_B**, we take the average value of the ex ante cost of equity from the following four valuation models: Model 1 (Claus & Thomas, 2001), Model 2 (Ohlson & Juettner-Nauroth, 2005), Model 3 (Gebhardt et al., 2001) and Model 4 (Easton, 2004). For the indicator of the ex ante **Cost of Equity COE_C**, the ex ante cost of equity derived from (Model 5) forward earnings/price ratio (Pinto, 2020). For more detailed information on how we estimate our sample firms' ex ante cost of equity, please refer to Appendix A. Robust *t*-statistics are reported in parentheses. Our dataset is composed of 10,367 firm-year observations from 1481 firms in 43 countries and territories from 2013 to 2019. We analyse our panel dataset by Panel EGLS cross-sectional weight with the white diagonal as our coefficient covariance method.
*Significance at 10% level.
**Significance at 5% level.
***Significance at 1% level.

4.4 | Hypothesis 3b: Empirical results

In the prior literature, scholars document that social, ethnic and national well-being or religious factors can influence individuals' financial decisions (Cui et al., 2019; Friede, 2019; Guiso et al., 2008; Heinkel et al., 2001; Hong & Kacperczyk, 2009; Stulz & Williamson, 2003; Yu et al., 2020). Based on the similar idea, we investigate how a country's human development progress may potentially influence firm's ex ante cost of equity through shaping investors' risk perception. In Hypothesis 3b, we use the HDI to represent a country's human development progress and overall national well-being (refer to Table 2 for the detailed definition).

Tables 7 and 8 present supporting evidence for Hypothesis 3b, which posits that an MNC headquartered in a country with better country human development progress can have a lower ex ante cost of equity. We observe that the coefficients of the country human development progress are consistently negative and significant at 1%–5% levels. Our findings support the argument that investors in a country with better human development progress have better abilities and/or opportunities to maximise the use of all available information in assessing a firm's future prospects in terms of riskiness. On the other hand, our results also imply that investors living in a country with an insufficient human development progress face a greater market information asymmetry than those who live in a country with a greater human development progress.

We include the interaction term ($ENVDISC_{t-1}$ * *a country's human development progress*$_{t-1}$) as one of our control variables. By doing so, we examine how a country's human development progress can influence the relation between companies' environmental disclosure and cost of equity through the interaction of environmental disclosure and a country's human development state, ($ENVDISC_{t-1}$ * *a country's human development progress*$_{t-1}$). According to the models presented in Tables 7 and 8, the coefficients of this interaction term ($ENVDISC_{t-1}$ * *a country's human development progress*$_{t-1}$) are consistently positive at 1% significant level. Our empirical results suggest that a firm disclosing more environmental information will increase its ex ante cost of equity because of greater scrutiny when headquartered in a country where citizens have better abilities or greater power to express their beliefs.

4.5 | Robustness checks

For robustness and to further corroborate our results, we employ an alternative indicator of voice and accountability from the World Bank (2018) to replace the HDI. The indicator of voice and accountability measures perceptions of the extent to which a country's citizens have freedom of expression in their beliefs and are also given rights in electing their government. Based on the models presented in Table 9, we still find consistent results for Hypothesis 3b. The direct effect of the indicator of voice and accountability ($Voice_{t-1}$) is negatively associated with the cost of equity at 1% level. The empirical evidence for Hypotheses 1, 2 and 3a remains the same. For example, all models in Table 9 show that there is a non-linear relationship between a firm's environmental disclosure and its ex ante cost of equity.

5 | CONCLUSION

A recently evolving shared belief around the world—that firms ought to report their influence on the planet—has persuaded investors to no longer view disclosing environmental information simply as a moral issue. More and more investors start perceiving environmental disclosure as crucial in helping them to make a better informed assessment of firms' future business scenarios. In this study, we examine how a company's quantity of environmental disclosure influences its ex ante cost of equity. Furthermore, we examine whether country features play a role in shaping this relation. By focusing on MNCs across many countries, our paper extends the prior literature which is mostly limited to single-country studies. Our study builds empirical support by employing a large international dataset consisting of 1481 firms from 43 countries and territories between 2013 and 2019. With an international dataset covering developed and developing nations, we observe a considerable cross-country variation. The empirical findings in this study help us to draw suggestions for public policy, firms' environmental strategy and their financial practice.

We start by measuring our sample firms' ex ante equity financing costs using five different valuation approaches all based on equity analysts' forecasted data. We consider the ex ante cost of equity as the most appropriate forward-looking estimation method as it reflects how investors price these firms' riskiness based on the information they are given. To avoid distortions and measurement problems from any particular approach, we use averages of those valuation models to gauge the firms' ex ante cost of equity.

Firstly, we demonstrate that there is a potential non-linear relation between a firm's environmental disclosure and its ex ante cost of equity through investors' risk perception. Our empirical evidence shows that the environmental information a firm discloses to the public is value relevant because of a reduction of shareholders' information asymmetry. Consequently, firms are able to reduce their ex ante cost of equity by selecting the optimal disclosure level in their environmental issues. However, our empirical results show that a firm can reduce its ex ante cost of equity by increasing its environmental disclosure up to a certain level, but beyond that point the ex ante cost of equity will start rising. By visualising how our sample countries spread around this U-shaped curve, we find most of our sample firms are to the left of this turning point and can benefit from revealing more environmental information to the public. For most sample firms, the environmental disclosure benefits outweigh their environmental disclosure costs. A company's environmental quantitative disclosure can change investors' perception of a firm's riskiness via the mechanism of reducing market information asymmetry, which in turn reduces the ex ante cost of equity.

We also examine the joint effects of a firm's GHG intensity and environmental disclosure on its ex ante cost of equity. We find that a firm with a higher GHG intensity is not reflexively penalised by investors with a higher required risk premium. Investors are willing to moderate their required risk premium when companies disclose more environmental data because their information asymmetry is reduced. Our findings imply that investors do not count a firm's GHG intensity alone but rather in association with its disclosed environmental information available to the public.

Finally, we contribute to the environmental and CSR literature by exploring whether non-financial country-level factors play a role in influencing how investors perceive a firm's riskiness after controlling for the level of environmental disclosure. Non-financial factors at the country level have so far received little attention. We provide supporting evidence on the important role of these two non-financial factors for a firm's ex ante cost of equity across countries: a country's environmental performance and its human development progress. When a multinational firm is domiciled in a country with a better country environmental performance and greater human development progress, investors perceive this firm to be less risky and thereby require a lower ex ante cost of equity. Our empirical results support that investors price these two non-financial country factors in their investment process.

In response to the increasing number of international agreements on climate protection and sustainability, improving a country's environmental performance has become a more important aim for policymakers. For instance, after the Paris Agreement signed in 2015, the efforts devoted by national governments have focused on reducing emissions and favouring the transition towards a low-carbon economy. Our findings make a case for policymakers to strengthen this goal further. In addition to a better environmental country performance being a worthwhile goal in itself, it can also promote their local equity markets and contribute to a better allocation of investors' resources. Based on our empirical evidence, firms in countries with better environmental performance are more likely to secure a lower cost of equity. Therefore, policymakers can attract MNCs to domicile in their countries since a better country environmental performance reduces companies' perceived environmental risk and the required equity risk premium.

Finally, our paper suggests that most of our sample firms will enjoy a cheaper cost of equity if they are more transparent with their environmental data. Our empirical findings echo the policies

set by the PRI (United Nations Principles of Responsible Investment), which aim to encourage investors to incorporate a firm's environmental information into their investment decisions. We find that a firm that discloses a greater amount of environmental information is perceived as less risky by the investors via the concept of market information asymmetry, which can result in a lower ex ante cost of equity. Our paper supports the demand for greater transparency in environmental issues at the company level, while we also identify several key factors which can influence investors' risk perception. A policy implication of our findings is that regulators, policymakers and companies should collaborate on developing a standardised corporate sustainability reporting on a global level, thereby providing investors with a more holistic view for evaluating the riskiness of their investments. Multinational firms will especially benefit from global standardised sustainability reporting since they raise capital in multiple financial markets.

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ENDNOTES

[1] In this study, the greenhouse gas intensity is defined as the ratio of a firm's total greenhouse gas emissions divided by its sales revenue. We convert this ratio to a common currency, the US dollar, in order to compare all our sample firms around the world.

[2] For the indicator of the ex ante **Cost of Equity COE_A**, we take the average value of the ex ante cost of equity from the following five valuation models: Model 1 (Claus & Thomas, 2001), Model 2 (Ohlson & Juettner-Nauroth, 2005), Model 3 (Gebhardt et al., 2001), Model 4 (Easton, 2004) and Model 5 (forward earnings/price ratio) (Pinto, 2020). For the indicator of the ex ante **Cost of Equity COE_B**, we take the average value of the ex ante cost of equity from the following four valuation models: Model 1 (Claus & Thomas, 2001), Model 2 (Ohlson & Juettner-Nauroth, 2005), Model 3 (Gebhardt et al., 2001) and Model 4 (Easton, 2004). For the indicator of the ex ante **Cost of Equity COE_C**, the ex ante cost of equity derived from (Model 5) forward earnings/price ratio (Pinto, 2020). For more detailed information on how we estimate our sample firms' ex ante cost of equity, please refer to Appendix A.

[3] To ensure the robustness of our regressions, we also use the alternative measurement (*GHG Scope* $1_{t-1}/EBITDA_{t-1}$) for the firm's greenhouse intensity.

[4] $0.1235*(-0.0256) = -0.0031$

[5] $(-0.0031)/0.1034 = -.0305$

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APPENDIX A. HOW TO ESTIMATE OUR SAMPLE FIRMS' EX ANTE COST OF EQUITY

We collect all equity analysts' earnings forecasts and actual share prices for our sample firms from Thomson Reuters I/B/E/S available in Eikon. A firm's ex-ante equity financing cost, representing as a firm's ex-ante cost of equity, can be calculated by adopting the following principle: the present value of future earnings forecasts on a sample firm will be equal to its current share price. Therefore, we can derive the internal rate of return from each valuation model described below and use it as a firm's ex-ante cost of equity in this study.

Here, we provide an explanation of our estimation process for the ex-ante cost of equity employing the equations (from Equation 2 to Equation 6) shown in Table 1 available in Section 3.1.1, which represent the five valuation models we use in this study. For the first four models (corresponding from Equation 2 to Equation 5), the ex-ante cost of equity is estimated for each sample firm and each year by solving for the ex-ante cost of equity R_i (the unknown term in the equation) that equates the prevailing share price and the valuation model price. In a more precise way and to take into consideration the relative different sensitivity of the model in relation to different levels of price, the cost of equity estimated is assumed to solve the optimisation problem when the absolute difference between the actual price and the estimated price with the ex-ante cost of equity is lower than 5% of the price. We remove the ex-ante cost of equity estimations that fail to satisfy this rule. Given that the optimisation problem can provide multiple results, the reiteration stops when a positive ex-ante cost of equity is found. When the solution is not strictly positive or when there is no solution to the problem, the observation of that cost of equity is put as missing. Finally, for all five models, we trim all the ex-ante cost of equity values, which are negative or greater than 1.